



# Science 8

## Module 4

# Mechanical Systems

## HOME INSTRUCTOR'S GUIDE AND ASSIGNMENT BOOKLET 4B



Learning  
Technologies  
Branch

**Alberta**  
LEARNING

Science 8  
Module 4: Mechanical Systems  
Home Instructor's Guide and Assignment Booklet 4B  
Learning Technologies Branch  
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**The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Home Instructor's Guide and Assignment Booklet.**

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	✓
General Public	
Other	



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- Alberta Learning, <http://www.learning.gov.ab.ca>
- Learning Technologies Branch, <http://www.learning.gov.ab.ca/lrb>
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## Section 3: Machine Technology and Society

In this section the student follows the development of the steam engine and internal combustion engines. The development of these engines brought about far-reaching changes in the way things were manufactured and transported. It also had a major effect on how people travelled. From this story of the development of engines, and more recent examples of technological change, the student develops a broader understanding of how people and machines affect each other and the environment.

The following materials will be needed to complete this section.

### Section 3: Lesson 1

- a large sheet of paper
- a small sheet of paper
- coloured felt markers
- tape

### Section 3: Lesson 2

No materials are needed for this lesson.

## Suggested Answers

### Section 3: Lesson 1

12. Students may mention any one of the given simple machines for each method.

water screw: screw, two wheel-and-axle devices (crank and shaft, shaft and screw cylinder)

well: wheel and axle, single fixed pulley

pump: Class 1 lever

faucet: Class 2 lever (handle), wheel and axle (or crank formed by a central shaft and handle)

**Note:** When the handle of the faucet is moved up and down, it is a lever. When it moves sideways, it serves as part of a wheel and axle.

## 13. Textbook questions 2 to 5 from “Topic 7 Review,” page 341:

2. In a steam engine, steam pushes a piston back and forth. This motion is converted to rotary motion to operate machines. In a steam turbine, steam passes over blades which spin on an axle (similar to a fan). This rotary motion can be used to drive machines directly.
3. Both devices convert the chemical energy of a fuel to thermal energy as a first step. In a steam engine, this conversion takes place in the boiler outside the engine where water is heated to steam. The steam then enters the cylinder where the piston is.

In an internal combustion engine, this conversion takes place inside the cylinder. The burning fuel mixture expands and pushes on the piston directly.

4. People initially had to travel to find food, shelter, and water. This travel was largely to meet basic needs. Today, people usually must travel to work or to school. They must also travel to get groceries and to obtain medical care. People must also travel for social reasons.
5. Answers will vary. Science and technology have changed the means of travel. The method of transport and the speed with which humans travel has changed. Travel distances and times and the amount that can be transported have also changed. Many smaller farms have been replaced by larger fields that can be planted and harvested faster. People and research devices can now move into outer space. In many cases the biggest and fastest transport inventions have had disastrous consequences. Safety and environmental issues are often in conflict with the human desire to transport and travel.

## Section 3: Lesson 2

1. It was discovered that Freon 12 reacts with high-level ozone. This reaction reduces the ozone layer. This atmospheric layer is necessary to protect life on Earth from ultraviolet radiation.
2.
  - a. Answers will vary. Vehicle traffic has led to air and water pollution; paving and water body removal has increased run-off; habitats have been split up, degraded, and/or destroyed; and many animals have been accidentally killed on roads.
  - b. Mass transit is one environmentally friendly response to population growth and city size. **Note:** However, mass transit is not available in many areas or not well used. Many people prefer the convenience of the automobile.
  - c. Commuters could car pool or ride bicycles to work.



**3. Textbook question from “Pause and Reflect,” page 342:**

Answers will vary greatly. Note the following:

- A greater interest in safety led to seatbelts and air bags in vehicles.
- A greater interest in energy conservation led to more efficient home furnaces and automobiles with less mass and smaller engines.
- A greater demand for international travel has led to the development of airplanes with room for hundreds of passengers.

**10. Textbook questions 1 and 2 from “Analyze,” page 347:**

1. Answers will vary. Both positive and negative points must be mentioned. Positive points include the following:

- All bicycles are an alternative to car transportation, resulting in a decrease in pollution and a lower need for large parking lots, as well as reduced traffic noise, and less congestion.
- They provide healthy recreational opportunities.
- The many gears and wider tires of mountain bikes allow off-road cycling.
- BMX and trick bicycles have positive, specialized characteristics, such as a small frame and smaller wheels.
- Compared to cars, bicycles use a lot less material and energy to build, run, maintain, transport, and so on.
- They do not run on non-renewable fuel.

Negative points include the following:

- Bicycles are generally seasonal (in Canada).
- Sharing the road with cars and trucks can be dangerous.
- Mountain bikes can be very hard on the natural environment as they cut out pathways that degrade habitat and cause erosion.
- Bikes are slower and more weather-dependent than car transportation.

- Riding bicycles requires a certain degree of physical fitness and maturity. For example, very young children cannot safely maneuver in street traffic.
- Bicycles may not be practical when long distances are involved.

2. From the buyer's immediate personal point of view, how well a mechanical device suits the buyer's purpose is what counts. The purpose of the mechanical device is the standard against which the device is assessed. If the device performs its intended function well, the buyer gets his or her money's worth. **Note:** A buyer should consider more than his or her own personal point of view. Positive and negative effects on society and the environment should be considered as well.

**13. Textbook questions 1, 2, 5, and 6 from "Topic 8 Review," page 350:**

1. Improvements in cars are often due to the application of scientific knowledge. For example, catalytic converters, air bags, streamlined shapes, fuel injection, high-intensity discharge lamp headlights, tinted glass, as well as shock absorbing bumpers and chassis are all due to such applications.
2. The first step in designing a new machine or modifying an existing machine is to establish its purpose. Ask the question, "What is it for?"
5. Technology uses scientific knowledge to solve problems and it provides the science community with the tools to gain even more knowledge. In other words, progress in science is helped by technology developments. But technological developments are also aided by scientific progress. That is what makes the relationship between science and technology like the "chicken and the egg."

The development of the microscope shows the relationship between science and technology. The invention of the microscope led to the discovery of bacteria. This led to a growing demand for more powerful microscopes for medical research. Greater knowledge about the nature of matter in general led to the development of the electron microscope.

The development of computers also shows the "chicken and the egg" relationship between science and technology. Computers were created using scientific (and mathematical) knowledge. Once computers were built, scientists used them for data analysis in a variety of fields. This led to a growth in genetics, population studies, and computer science. Using the advances in computer science, the next generation of computers was developed.

6. Technologies such as the microscope, telescope, computer, sonar radar, imaging technologies, and isotope-dating improve the ability of people to study science.



## Section 3: Review

Textbook questions 5 and 10 from “Wrap-up: Topics 7 and 8,” page 351:

5. A practical steam engine and an increase in the availability of iron made the building and operating of large factories possible. The factories were able to cheaply produce large quantities of standardized goods. Prior to this, goods were made by hand and each piece was an original.
10. A road bike has smooth, narrow tires that use high pressure to reduce rolling resistance to a minimum. Mountain-bike tires are designed for maximum traction and use a lower tire pressure; this brings a penalty of increased rolling resistance.

Road bikes have gear ratios to maximize speed; they have higher gears but not as many low gears. Mountain bikes have many low gears and fewer high gears. This means mountain bikes can climb steeper hills.

Road bikes tend to have a longer frame—the rider is stretched forward for a lower profile. Mountain bikes have shorter frames. The rider sits more erect for better downhill control and better visibility.

## Module Review

Textbook questions 1, 4, and 6 from “Understanding Key Concepts;” 13 and 19 from “Developing Skills;” 21, 22, and 27 from “Problem Solving/Applying;” and 30 and 31 from “Critical Thinking;” pages 356 to 359:

1. Work is a transfer of energy from one object to another through motion OR work is done when a force is exerted through a distance. The amount of work done is equal to the product of force and the distance through which the force is applied.

Work = Force  $\times$  distance

$$W = Fd$$

Mechanical advantage (*MA*) is a ratio of the force produced by a machine or system (the load force) to the force applied to the machine or system (the effort force).

**Note:** The mechanical advantage can also be found using other formulas, such as the following.

$$MA = \frac{\text{effort arm length}}{\text{load arm length}}$$

4. Answers will vary. Friction is useful between
- a person's shoes and the floor
  - the legs of a table and the floor
  - a nail and the wood it is in
  - a bicycle tire and the ground
6. For the pulley system,  $MA = 4$ . Four strings support the load. The fifth one merely changes the direction of the force. The mechanical advantage is equal to the number of supporting ropes in the pulley system.
13. Taken out of the concept map, the sentences will read as follows: Simple machines can be a *lever*, *inclined plane* (screw, wedge), *wheel and axle*, or *pulley*. Simple machines do *work*, which is related to *efficiency*. Simple machines give you a *mechanical advantage*, which compares *load* to *effort force*.
19. Answers will vary. The design has to address the need to use the pen with little force and without fine control of the fingers. For example, make the barrel large enough so that the pen can be used without having to close the fingers fully. A soft, spongy wrap around the barrel is also desirable (it provides comfort and some friction for an easier grip).

**Note:** Another solution for the need for a writing instrument might be writing with a voice-operated, speech-sensitive computer.

21. The gear in which you pedal fast but travel slowly would be used to climb a steep hill or move against a strong wind. In this gear, you would apply a small effort force on the pedals over a long distance.
22. 
$$MA = \frac{\text{load force}}{\text{effort force}}$$

$$= \frac{1000 \text{ N}}{200 \text{ N}}$$

$$= 5$$



For a mechanical advantage of 5, the large piston must have an area 5 times the area of the small piston.

$$\begin{aligned}\text{Area of large piston} &= 5 \times 25 \text{ cm}^2 \\ &= 125 \text{ cm}^2\end{aligned}$$

The area of the large piston must be 125 cm<sup>2</sup>.


27. Answers will vary. They may include the following:

- Freon 12, used as a coolant in refrigerators and air conditioners, was found to contribute to the destruction of the ozone layer. Other, more environmentally friendly coolants have replaced it.
- Automobile fuels containing lead added to air pollution from exhaust. A law was enacted that forced the removal of lead from fuels. Alternative energy sources are currently being studied in an effort to further decrease the air pollution from automobile exhaust.

30. Machines can make work easier by reducing the effort force needed. Also, machines can make work easier by reducing the speed at which the effort has to be applied. But in using a machine, the effort force needed must overcome the friction of moving parts of a machine. In overcoming friction, the amount of work will be more than if no machine was used.

31. If the brake system developed a hole and the hydraulic fluid leaked, the system could stop transferring force.

A hydraulic system likely transfers force more efficiently than a mechanical system. Fewer moving parts and a self-lubricating system means less friction to convert useful energy into heat. Fewer parts also means that there are fewer components to wear out.



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## ASSIGNMENT BOOKLET 4B

Science 8

Module 4: Section 3 Assignment and Final Module Assignment

Home Instructor's and Student's Comments:

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Date Assignment Received:

Grading:

Teacher's Comments

Teacher's Signature

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- Are all the assignments completed? If not, explain why.
- Has your work been reread to be sure the spelling and details are correct?
- Is the record form filled out and the correct module label attached?

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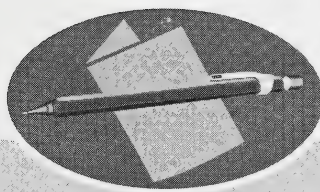


# **Science 8**

## **Module 4**

### **Mechanical Systems**

#### **ASSIGNMENT BOOKLET 4B**



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## FOR TEACHER'S USE ONLY

### Summary

	Total Possible Marks	Your Mark
Section 3 Assignment	16	
Final Module Assignment	38	
	54	

### Teacher's Comments

Science 8  
Module 4: Mechanical Systems  
Assignment Booklet 4B  
Section 3 Assignment and Final Module Assignment  
Learning Technologies Branch

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**ASSIGNMENT BOOKLET 4B**  
**SCIENCE 8: MODULE 4**  
**SECTION 3 ASSIGNMENT AND FINAL MODULE ASSIGNMENT**

Your mark for this module will be determined in part by how well you do your assignments.

This Assignment Booklet is worth 54 marks out of the total 142 marks for the assignments in Module 4. The value of each assignment and each question is stated in the left margin.

Work slowly and carefully. If you have difficulty, go back and review the appropriate section.

Be sure to proofread your answers carefully.

16

**Section 3 Assignment: Machine Technology and Society**

**Read all parts of your assignment carefully and record your answers in the appropriate places.**

1

- 1.** Circle the letter of the best response.

Where is the fuel for a steam engine burned?

- A. in the cylinder of the engine
- B. in the crankcase
- C. under a boiler
- D. in a booster

Use the following information to answer question 2.

In developing an airplane, some of the following steps are taken:

- (a) The wings are shaped so that air travels faster over their top surface than their bottom surface. The faster-flowing air creates lift, according to Bernoulli's principle.
- (b) The airplane hydraulic lines are made strong enough to withstand the pressure predicted by Pascal's law.
- (c) A test pilot flies the airplane before it is put to regular use.
- (d) Based on its low density, aluminum is chosen for the skin of the airplane.
- (e) A model of the plane is flown in a wind tunnel.

①

2. Circle the letter of the best response.

Which steps are most closely related to trial and error rather than the application of scientific knowledge?

- A. (a) and (b)
- B. (b), (d), and (e)
- C. (c) and (d)
- D. (c) and (e)

①

3. In the late 1800s, there was a need to transport farming equipment and materials of the fur trade over the Prairies. What kind of vessel was used on the North Saskatchewan, the South Saskatchewan, and the Assiniboine Rivers for such transportation?
- 

Use the photograph to answer question 4.



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①

4. A windmill still stands in this abandoned farmyard. Infer what the purpose of this windmill was.
- 
-



④

5. Look at the various models of passenger cars in Figures 4.67, 4.68, and 4.69A on pages 344 and 345 of the textbook. Suppose you had to help your family make a choice about the purchase of another vehicle and the textbook models represented some possible alternatives.



Write down four questions that would help you evaluate the alternatives and make the best choice for a new vehicle. Include at least one question that goes beyond just your own family's concern. Think of the societal and environmental impacts.

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③

6. You have been asked to improve a shopping cart's design. List three questions you could ask to guide your changes.

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③

7. The use of bicycles as a mode of transportation is environmentally friendly. Name three ways in which using bicycles is more environmentally friendly than using automobiles.

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②

8. Describe two ways the Alberta environment could affect the development of a machine.

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Return to page 73 of the Student Module Booklet and continue with the Module Summary.

38

## Final Module Assignment

**Read all parts of your assignment carefully and record your answers in the appropriate places.**

1. You have 12 meshing gears in a set of gears. The gears have the following number of teeth—A: 60; B: 50; C: 40; D: 30; E: 20; and F:10. There are two gears of each size in your set. Your task is to transfer force and motion in a controlled manner by using an appropriate gear train.

**Note:** No chain is available for you to use.

2

- a. Explain why it is a good idea to use the fewest number of gears possible to complete the required task.

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2

- b. Sketch a gear train that will provide the highest possible speed ratio without changing the direction of motion. Do not draw teeth on the gears. Label each component clearly. Identify the driving and driven gears.

2

- c. Sketch a gear train that will provide a mechanical advantage of 3 and changes the direction of motion—effort force and load force move in the same direction. Do not draw teeth on the gears. Label each component.



Circle the letter of the best response for questions 2 and 3.

①

2. Which of the following is a Class 3 lever?

A. a baseball bat in the hands of a batter  
B. a pair of pliers  
C. a seesaw or a teeter-totter  
D. a wheelbarrow

①

3. Which of the following is a Class 2 lever?

A. a pair of tweezers  
B. a pair of scissors  
C. a broom in the hands of a sweeper  
D. a bottle opener

②

4. Name a mechanical device that has changed due to societal concerns. Do not use any of the machines or devices shown or referred to in this module. Explain how and why it has changed.

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②

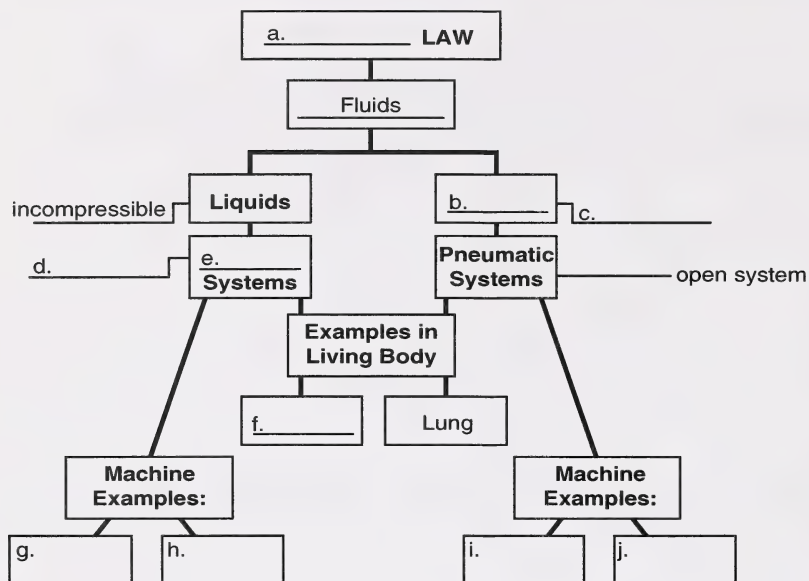
5. Refer to the photo on page 357 of the textbook. Two simple machines combine to make an axe in the hands of the woodcutter. One of them is a Class 3 lever. What is the other? Explain.



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6. The concept map that follows has not been completed. Letters stand for parts that are missing.



5

Indicate the missing information in the flowchart by writing down what word or words each letter represents.

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

d. \_\_\_\_\_

e. \_\_\_\_\_

f. \_\_\_\_\_

g. \_\_\_\_\_

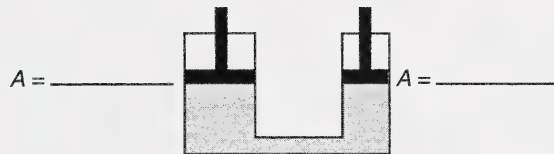
h. \_\_\_\_\_

i. \_\_\_\_\_

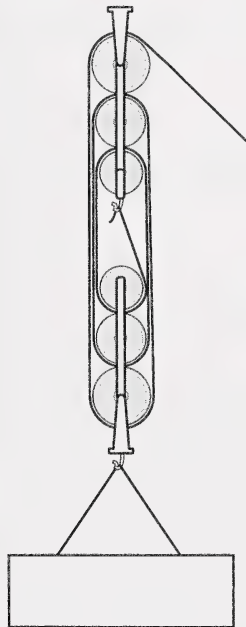
j. \_\_\_\_\_



- ③ 7. Label this hydraulic lift. The system is to provide a mechanical advantage of 2. Provide appropriate area measurements. Identify the effort piston and load piston. Use arrows to show the direction of motion while the load is lifted.



8. Use the diagram to answer the questions.



- ② a. What is the mechanical advantage of the pulley system? Explain your answer.
- \_\_\_\_\_
- \_\_\_\_\_
- ② b. Suppose you can exert a force of 50 N. What is the maximum weight that you can lift with the pulley system? Show your calculation.

②

- c. Suppose you pull the rope end coming off the top of the pulley system a total of 24 cm. How far will the load move up? Explain.

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Circle the letter of the best response for questions 9 and 10.

①

9. A gear train consists of three gears. Between the driving gear and the driven gear is a middle gear. The driving gear has 30 teeth, the middle gear has 15 teeth, and the driven gear has 10 teeth. What is the speed ratio of the gear train?

A.  $\frac{1}{3}$   
B.  $\frac{1}{6}$   
C. 3  
D. 6

①

10. The water screw, the pump, the bucket, and the faucet are mechanical devices used to obtain water. Which of these mechanical devices is the newest?

A. pump  
B. faucet  
C. water screw  
D. well and bucket

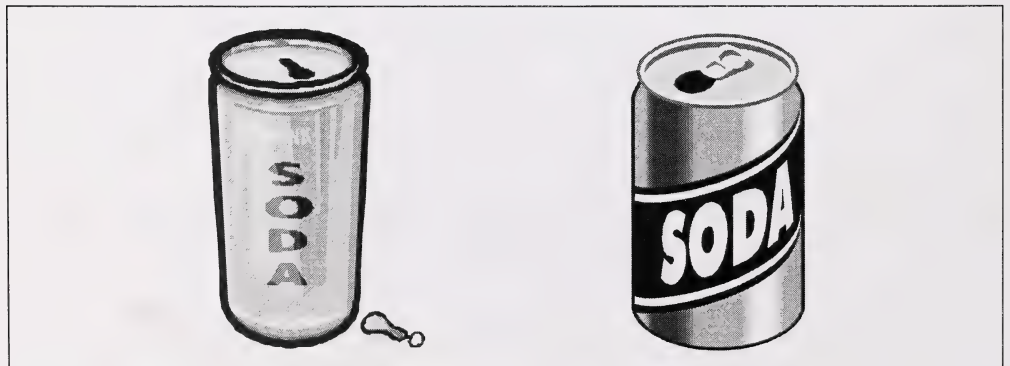
②

11. The need to travel has been met in different ways. Name four different non-motorized mechanical devices people use to travel.

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Use the following information to answer question 12.





- ③ 12. An early version of soft-drink containers had a removable tab. With thousands of these cans in use, a great number of tabs became litter. When this littering was recognized as an environmental problem, the soft-drink can with a non-removable tab was developed.

In technological development, both trial and error and the use of scientific knowledge play a role. Describe the role of trial and error in this development of a soft-drink tab.

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- ④ 13. Match each device on the left with its source of energy from the right. Fill in the answer blanks to the left of the devices.

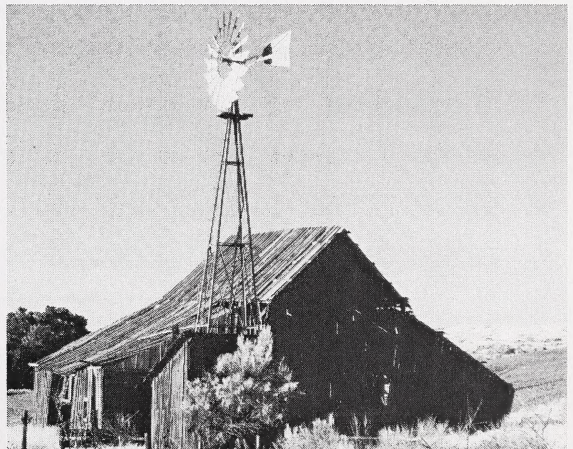
_____ a. automobile	A. fluid pressure
_____ b. roller blades	B. electricity
_____ c. fire extinguisher	C. human
_____ d. home refrigerator	D. fuel

Use the photograph to answer question 14.

- ① 14. Circle the letter of the correct response.

What is the source of energy for the windmill?

- A. electricity
- B. human
- C. water
- D. wind



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**Submit your completed Assignment Booklet 4B to your teacher for assessment.**





## ASSIGNMENT BOOKLET DECLARATIONS

The Student's Declaration is to be signed by a student registered at the Alberta Distance Learning Centre. If the student is under 16, the Supervisor's Declaration is to be signed by the student's supervisor, who is usually a home instructor, teacher, or home-schooling coordinator. Failure to complete this page may invalidate the assignment results.

### STUDENT'S DECLARATION

- I have followed the instructions outlined in the Student Module Booklet.
- I have completed the activities to prepare myself for the assignments in this Assignment Booklet.
- I completed the assignments in this Assignment Booklet by myself.

\_\_\_\_\_  
Student's Signature

### SUPERVISOR'S DECLARATION

I hereby certify that I have supervised the learning activities completed by \_\_\_\_\_.  
Student's Name

I also certify that to the best of my knowledge the assignments in this Assignment Booklet were completed independently by this student.

\_\_\_\_\_  
Supervisor's Signature

If you, the student or supervisor, have any comments or observations regarding this module, write them in the following space.

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# EXERCISES

The first exercise is to find the area of a triangle. The second exercise is to find the area of a rectangle. The third exercise is to find the area of a circle. The fourth exercise is to find the area of a parallelogram. The fifth exercise is to find the area of a trapezoid. The sixth exercise is to find the area of a square. The seventh exercise is to find the area of a rhombus. The eighth exercise is to find the area of a kite. The ninth exercise is to find the area of a regular polygon. The tenth exercise is to find the area of an irregular polygon.

## EXERCISES

1. Find the area of a triangle with base 10 and height 5.

2. Find the area of a rectangle with length 12 and width 8.

3. Find the area of a circle with radius 7.

4. Find the area of a parallelogram with base 15 and height 10.

5. Find the area of a trapezoid with bases 10 and 15 and height 8.

6. Find the area of a square with side length 12.

7. Find the area of a rhombus with side length 10 and one angle 60 degrees.

8. Find the area of a kite with diagonals 12 and 16.

9. Find the area of a regular hexagon with side length 10.

10. Find the area of an irregular polygon with vertices at (1,1), (4,4), (6,6), (8,8), (10,10), (12,12), (14,14), (16,16), (18,18), (20,20), (22,22), (24,24), (26,26), (28,28), (30,30), (32,32), (34,34), (36,36), (38,38), (40,40), (42,42), (44,44), (46,46), (48,48), (50,50), (52,52), (54,54), (56,56), (58,58), (60,60), (62,62), (64,64), (66,66), (68,68), (70,70), (72,72), (74,74), (76,76), (78,78), (80,80), (82,82), (84,84), (86,86), (88,88), (90,90), (92,92), (94,94), (96,96), (98,98), (100,100).

## EXERCISES

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5. Find the area of a trapezoid with bases 10 and 15 and height 8.

6. Find the area of a square with side length 12.

7. Find the area of a rhombus with side length 10 and one angle 60 degrees.

8. Find the area of a kite with diagonals 12 and 16.

9. Find the area of a regular hexagon with side length 10.

10. Find the area of an irregular polygon with vertices at (1,1), (4,4), (6,6), (8,8), (10,10), (12,12), (14,14), (16,16), (18,18), (20,20), (22,22), (24,24), (26,26), (28,28), (30,30), (32,32), (34,34), (36,36), (38,38), (40,40), (42,42), (44,44), (46,46), (48,48), (50,50), (52,52), (54,54), (56,56), (58,58), (60,60), (62,62), (64,64), (66,66), (68,68), (70,70), (72,72), (74,74), (76,76), (78,78), (80,80), (82,82), (84,84), (86,86), (88,88), (90,90), (92,92), (94,94), (96,96), (98,98), (100,100).